



Lesser white-toothed shrew *Crocidura suaveolens* (Soricidae, Mammalia) in the diet of *Tyto alba* from the Lower Vistula Valley (north Poland)

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Abstract: The species composition of a small mammal community in the diet of the Barn Owl *Tyto alba* was examined at two sites near the town of Świecie nad Wisłą (northern Poland). Bones of 161 prey were extracted from *T. alba* pellets collected in 2021 and 2023. A total of 14 mammalian species were recorded: Soricomorpha (3) and Rodentia (11). The dominant species in the diet of *T. alba* at both sites was *Microtus arvalis*, accounting for 24–48%. The second most common species in the diet of owls was *Sorex araneus*. A significant difference between the sites is the ratio of Microtidae to Muridae in the food of the Barn Owl. The most interesting species was *Crocidura suaveolens*, whose localities are located outside the previously known north-eastern limit of its range. Possible pathways for the spread of this species beyond its current geographic range are discussed.

Key words: owl pellets, Rodentia, Soricomorpha, *Crocidura suaveolens*, range extension, N Poland

INTRODUCTION

The range of the lesser white-toothed shrew covers the Palearctic, including Central Europe, Israel, Saudi Arabia, Asia Minor, the Caucasus, Kyrgyzstan, north-eastern China, and Korea (Libois et al. 1999). In Poland, it occurs in the southern and western parts of the country (Pucek 1984). The last published report on the range of this species in Poland (Cichocki et al. 2014) confirmed that this representative of insectivores occurs mainly in southern and western Poland, with the only locality north of the Noteć River and west of the Vistula River being the town of Połczyn Zdrój (53.76°N, 16.09°E) in the West Pomeranian Lakeland.

The latter publication further shows that the method of studying the composition of local fauna based on the analysis of owl pellets is a labour-intensive method, but in the case of this species highly effective, as more than 70% of the records were obtained by analysing owl food. So far, despite fairly intensive research on owl food in northern Poland, e.g. in the Starogard Lakeland and Elbląg Upland (Hetmański 1993), Pomerania (Hetmański et al. 2008), Tuchola Forest (Dąbrowska 1992, Hajdamowicz 1992), Chełmno Lakeland (Neubauer 2001, Tomaszewski 2005), Dobrzyń Lakeland (Strzelecki 1998), Toruń and its vicinity (Kasprzyk & Zalewski 1992, Zalewski 1994), *Crocidura suaveolens* has not been found.

Changes in land use and observed climatic changes can induce changes in the distribution of species, especially thermophiles. Recognising the distribution of rare species is a prerequisite for managing their populations and implementing targeted conservation and other measures that affect land use patterns.

The objective of the study was to check the species composition of small mammals in the diet of Barn Owl in Lower Vistula Valley with a view to finding new locations of rare mammal species.

MATERIAL AND METHODS

This study is based on data from the analysis of Barn Owl *Tyto alba* (Scopoli, 1769) pellets collected in the villages of Chrystkowo (53.32°N, 18.31°E) and Kosowo (53.35°N, 18.37°E), approximately 5 km apart. Both sites are located in the Lower Vistula Valley, where Olenders and Mennonites – religious refugees from the borderland between today’s Germany and the Netherlands – had been settling since the 17th century. The settlers’ housing and livestock buildings were built on floodplains, which is why they were located on natural or artificially raised hills.

The pellet collection site in Chrystkowo is a typical Olender cottage from the end of the 18th century with a two-storey structure adapted to flooding. The attic was used on a daily basis for household purposes, and in the event of a flood, the life of the house’s inhabitants moved there.

In Kosowo, pellets were collected in a modern barn used to store hay and straw. Today, both villages lie in a non-flood zone, as the Vistula riverbed and its narrow floodplain were embanked with flood embankments at the end of the 19th century.

The owl hunting area is a typical agricultural landscape dominated by grassland and cereal crops. The pellets collected at both sites were fresh, but no continuous inhabitation of the objects by these predators was observed. Pellet analysis was carried out using standard methods (Raczyński & Ruprecht 1974). The taxonomic determination of small mammals was performed on the basis of skull, mandible and teeth parameters (Pucek 1984). The osteological material of *Crocidura suaveolens* for this study was analysed and determined based on metric and non-metric characters (Ruprecht 1971, Michalak 1989).

RESULTS

A total of 161 prey items belonging to 14 species were identified. The diet consisted entirely of small mammals represented by rodents and insectivores (Table 1). Rodents were found to be the primary diet of the Barn Owl, accounting for more than 77% of the diet in terms of abundance at both sites. A significant difference between the sites is the ratio of Microtidae to Muridae, with Arvicolidae clearly dominating in Kosowo and with a percentage ratio of these families of 61.2% to 15.5%, while in Chrystkowo it was 43.1% to 34.5%.

Table 1. Number of individuals of small vertebrates caught by the Barn Owl at the sites in the Lower Vistula Valley.

No.	Prey	Chrystkowo			Kosowo		
		13 Mar 2021	15 Oct 2023	Total (%)	24 Sept 2023	15 Oct 2023	Total (%)
1.	<i>Sorex araneus</i> Linnaeus, 1758	4	2	6 (10.3)	10	4	14 (13.6)
2.	<i>S. minutus</i> Linnaeus, 1766	2	2	4 (6.9)	3	3	6 (5.8)
3.	<i>Crocidura suaveolens</i> (Pallas, 1811)	3		3 (5.2)	4		4 (3.9)
4.	<i>Arvicola amphibius</i> Linnaeus, 1758				1		1 (1.0)
5.	<i>Clethrionomys glareolus</i> (Schreber, 1780)	1		1 (1.7)	1	1	2 (1.9)
6.	<i>Microtus subterraneus</i> (de Selys-Longchamps, 1836)				1	3	4 (3.9)
7.	<i>M. arvalis</i> (Pallas, 1779)	6	8	14 (24.1)	41	9	50 (48.5)
8.	<i>M. oeconomus</i> (Pallas, 1766)	4	1	5 (8.6)	3	3	6 (5.8)
9.	<i>Mus musculus</i> Linnaeus, 1758	2	1	3 (5.2)	2	1	3 (2.9)
10.	<i>Rattus norvegicus</i> (Berkenhout, 1769)	1		1 (1.7)	1		1 (1.0)
11.	<i>Apodemus agrarius</i> (Pallas, 1771)	5	2	7 (12.1)	1	5	6 (5.8)
1.2	<i>A. sylvaticus</i> Linnaeus, 1758		3	3 (5.2)	1	2	3 (2.9)
13.	<i>A. flavicollis</i> (Melchior, 1834)	4	3	7 (12.1)	1	1	2 (1.9)
14.	<i>A. flavicollis/sylvaticus</i>		2	2 (3.4)			
15.	<i>Micromys minutus</i> (Pallas, 1771)	2		2 (3.4)		1	1 (1.0)
	Total	34	24	58 (100.0)	70	33	103 (100.0)

The second order with the highest relative abundance in the diet was Soricomorpha, accounting for 22.4% in Chrystkowo and 23.3% in Kosowo. The dominant species at all sites was the *Microtus arvalis*, whose relative abundance ranged from 24% in Chrystkowo to over 48% in Kosowo. *Sorex araneus* was the second most common prey species in the diet, with a relative abundance of 10.3% and 13.6%, respectively.

A significant difference between the sites is the high relative abundance (12.1%) of *Apodemus flavicollis* in Chrystkowo with a minimal proportion of this species (1.9%) in the food of the Barn Owl in Kosowo.

The records of *Crocidura suaveolens* include three individuals found in the food of Barn Owls at the end of the winter of 2021 in Chrystkowo and four individuals inhabiting a barn in Kosowo in the summer of 2023 (Table 1).

DISCUSSION

As an opportunistic predator, the Barn Owl hunts prey according to its availability (Mikkola 1983), which is why in agricultural landscapes the prey is usually *Microtus arvalis*, and the co-dominant food is *Sorex araneus*. The Vistula Valley presents typical habitats transformed by man into agricultural land, so the species composition of prey and the frequency of capture of individuals representing specific species by the Barn Owl in the study area do not differ significantly from those found in other regions of Poland (Ruprecht 1979, Sałata-Piłacińska & Rachowiak 1990, Lesiński 1991, Sałata-Piłacińska 1994, Bekasiński et al. 1996). A significant difference is the absence of sparrows *Passer domesticus* and the low incidence of *Mus musculus*. The analysed dataset is relatively small, hence the low relative abundance of individual species or lack thereof may be due to randomness. Recently, however, many authors have pointed to a link with changes in agriculture and the current type of residential development, which may result in a reduction in the abundance of synanthropic species in ecosystems and, ultimately, in the diet of predators (Urbanek & Pyziołek 2007, Roulin 2015).

The new localities of *C. suaveolens* in the Lower Vistula Valley are located north-east of the previously known range of this species. The closest sites known from the literature (Cichocki et al. 2014) are located in the Greater Poland Lakeland and are 110–120 km in a straight line to the south-west. Due to the distance from the previously defined distribution limit, the question remains as to whether this is an island population as a result of recent introduction by humans or as a result of the natural process of the spread of the species.

The first hypothesis is confirmed by the biology of species from the Crocidurinae subfamily. The anthropophilic behaviour and a tendency to adhere to human settlements is characteristic of the lesser white-toothed shrew in particular (Eichstädt 1991, Schmidt 1998, Estafiev 2006, Gorbunova & Tretyakov 2009).

Such coexistence with humans promotes incidental movement with goods and helps overcome land and water barriers (Genoud & Hausser 1979). Such a scenario of colonisation of some Mediterranean islands in the past has been demonstrated for several insectivorous species (Vigne et al. 1997, Dobson 1998, Dubey et al. 2007, Rofes et al. 2018). Contemporary examples of the introduction of *Crocidura russula*, a species with similar biology, occurred in Ireland (Tosh et al. 2008, McDewitt et al. 2014).

The introduction of *C. suaveolens* may have taken place from Western Europe with goods transported along the Vistula River during the intensive migrations of the Olenders and Mennonites in the Lower Vistula Valley in the 17th and 18th centuries. However, in the case of the former introduction, the range of such a population should be larger. For example, the rate of expansion of *C. russula* in a homogenous Irish landscape was determined to be 5.5 km/year (McDewitt et al. 2014).

The two described sites are located at a distance of approximately 5 km from each other, but the species was not found during research on owl food in the vicinity of the Vistula Valley in the Tuchola Forest, the Chełmno Lakeland, and even in the food of the Barn Owl inhabiting the castle in Świecie, approximately 8 km away (Kasprzyk, unpubl. data). A possible vector for a more contemporary introduction could be the transport of wood from the *C. suaveolens* distribution area to a nearby cellulose factory located about 4 km from Kosowo in Przechowo.

A natural range expansion scenario, such as we observe in Germany (Jentzsch & Trost 2008) is unlikely in this case, as the distance from the known sites in the Noteć Valley exceeds 120 km (Węglewo XU17, Cichocki et al. 2014). On the other hand, the significant northward shift of the range observed in central Poland (Lesiński 2024) indicates recent significant changes in the occurrence of the species in this part of its European range. Addressing these questions requires further research into the occurrence of the species in the vicinity of the finds, while a definite resolution of the issue would be possible using genetic techniques.

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STRESZCZENIE

[Zębielek karliczek *Crocidura suaveolens* (Soricidae, Mammalia) w pokarmie płomykówki *Tyto alba* z Doliny Dolnej Wisły (północna Polska)]

Na podstawie analizy materiału kostnego pochodzącego z wypluwek płomykówki zebranych na dwóch stanowiskach (Chrystkowo i Kosowo) w okolicy Świecicia nad Wisłą (Dolina Dolnej Wisły) określono skład gatunkowy i strukturę dominacyjną ofiar w diecie tej sowy. Obie miejscowości leżą w obrębie pierwotnej terasy zalewowej zasiedlanej w XVII i XVIII wieku przez uchodźców religijnych z obszaru pogranicza dzisiejszych Niemiec i Holandii. Dziś obie miejscowości leżą w typowych obszarach rolniczych w strefie poza zalewowej, gdyż pod koniec XIX wieku koryto Wisły wraz ze wąską strefą zalewową zostało obwałowane wałami przeciwpowodziowymi. Z materiału zebranego w latach 2021 i 2023 wypreparowano 161 ssaków, należących do 14 gatunków. W zbiorze występowały gatunki drobnych ssaków typowe dla mozaiki środowisk, a zdecydowanie dominował *Microtus arvalis* osiągający od 24% do 48% udziału w diecie sowy. Drugim gatunkiem pod względem udziału liczebnego była ryjówka aksamitna *Sorex araneus* osiągająca od 10,3% do 13,6% udziału w pokarmie. Znaczącą różnicą w pokarmie sów pomiędzy stanowiskami był udział myszarki leśnej *Apodemus flavicollis*, której znacznie więcej zanotowano w Chrystkowie (12,1%) niż w Kosowie (1,9%). W stosunku do innych badań pokarmu płomykówki w Polsce zasiedlających podobne biotopy brak jest w pokarmie wróbla *Passer domesticus* i stwierdzono niewielki udział myszy domowej *Mus musculus*, co prawdopodobnie wynika ze zmian w krajobrazie rolniczym. Najbardziej interesującym faunistycznie jest stwierdzenie *Crocidura suaveolens* poza dotychczas znanym zasięgiem w Polsce. Dwa nowe stwierdzenia leżą w linii prostej od znanych w literaturze o ok. 110-120 km w kierunku północno-wschodnim. W analizie uwzględniono scenariusze zakładające naturalne rozprzestrzenienie i przypadkowe zawleczenie gatunku poza dotychczas znane granice zasięgu.